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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of **Krishnamachari, S.** Atty. Docket No.: **PHA 23-431A**
Serial No.: **09/934,962** Group Art Unit: **2623**
Filed: **8/22/2001** Examiner: **Wu, J.**
Title: **COLOR QUANTIZATION AND SIMILARITY MEASURE FOR CONTENT BASED IMAGE RETRIEVAL**

REPLY BRIEF

Honorable Commissioner for Patents
Alexandria, VA 22313-1450

Sir:

This is a reply to the Examiner's Answer to the Applicant's Appeal Brief in the subject application, dated 8 April 2003.

GROUPING OF CLAIMS

The Examiner's Answer states that all claims stand or fall together. The Applicant respectfully notes that in the Applicant's Brief, the Applicant stated that claims 1-5 and 11-15 stand or fall together, and that claims 6-10 and 16-20 stand or fall together. As noted in the Applicant's Brief, claims 1-5 and 11-15 are patentably distinct from claims 6-10 and 16-20 because claims 1-5 and 11-15 claim a method and system for characterizing images, whereas claims 6-10 and 16-20 claim a method and system for comparing two or more images.

CLAIMS APPEALED

The Examiner's Answer notes that the appealed claims in the Applicant's Brief were not correct, because a requested amendment under 37 CFR 1.116 was not admitted. Attached is a corrected set of claims.

GROUNDS OF REJECTION

The Examiner disagrees with the Applicant's assertion that "Sato does not perform a comparison of frequency of occurrences of colors in each region of an image, as specifically claimed" (Examiner's answer, page 3, lines 14-15).

The Applicant respectfully notes that in Sato, a comparison of images uses the index table of FIG. 45. The Applicant agrees with the Examiner that the index table of FIG. 45 is created based on a histogram of colors in each region, as illustrated in FIG. 43 and the flowchart of FIG. 44, and agrees with the Examiner that a histogram represents frequency of occurrences. The Applicant also agrees with the Examiner that Sato searches for images in the database by a comparison of Sato's index table (Examiner' Answer, page 4, lines 5-6). However, the Applicant respectfully maintains that the index table of FIG. 45 does not contain frequencies of occurrences, and thus the use of the index table to compare images does not include a comparison of frequencies of occurrences of colors.

The columns of Sato's index table are different levels of "resolution"; the larger the block size, the lesser the resolution. The rows of Sato's index table are each of the different colors contained in the image. The entries within the table are identifiers of regions of the image that exhibit at least a threshold amount of a particular color at the given resolution. As specifically illustrated at S175 of Sato's FIG. 44, the entry at column Ci and resolution R in the index table is "IMAGE ***id***, REGION ***id***", where ***id*** is an abbreviation of ***identifier***, and not frequency of occurrence of color Ci. If the histogram of FIG. 43 shows that a particular color in a region exceeds a resolution-dependent threshold value, the identifier of that region is entered in the index table of FIG. 45 for that color at that resolution.

In Sato's example entry in FIG. 45, "IMAGE 1, REGION 1" contains at least a threshold amount of color C1, and "IMAGE 2, REGION 3" also contains at least a threshold amount of color C1. It is ***impossible*** to determine from Sato's index table whether "IMAGE 1, REGION 1" has fewer or more pixels of color 1 than "IMAGE 2, REGION 3". The Examiner asserts that the index to this table, color C1, contains both the color and its frequency of occurrence (Examiner's Answer, page 4, lines 7-8). The Applicant must then ask, if this assertion is correct, does the color C1 represent the

frequency of occurrence of the color in "IMAGE 1, REGION 1" or in "IMAGE 2, REGION 3"? Obviously, except when the frequency of occurrences of each are identical, it cannot represent the frequency of occurrence of both, because if it represented the frequency of occurrence of colors in "IMAGE 1, REGION 1", then the entry of "IMAGE 2, REGION 3" in this row is incorrect; likewise, if it represents the frequency of occurrence in "IMAGE 2, REGION 3", then the entry of "IMAGE 1, REGION 1" is incorrect.

Consider, for example, a threshold value of 5 being defined for a block size of 16. If a region of 16 pixels includes five or more pixels of a given color, the identifier of that region is entered in the "BLOCK SIZE: 16" column at the row corresponding to the given color. Of particular note, in this example, if "IMAGE 1, REGION 1" is a region that contains five pixels of color C1, the identifier of this region will appear in the index table. If "IMAGE 2, REGION 3" contains all sixteen pixels of color C1, it will also appear in the index table. The entries in column C1 merely conveys that both regions have a threshold amount of color C1, it does not convey the actual frequency of occurrence, and thus the use of this table for subsequent comparisons, as taught by Sato, is not a comparison of the determined frequencies of occurrences, as specifically claimed in the Applicant's claims 6-10 and 16-20.

In Sato, when images are compared, the comparison is based on whether the corresponding regions contain the same colors, as identified in the index table, and not on whether they contain the same ***amount*** of each color, as taught and claimed by the Applicant.

In the Applicant's invention, a 16-pixel region of a first image that contained five pixels of a color would be distinguished from a 16-pixel region of a second image that contained sixteen pixels of the color, because the frequency of occurrences of each color is compared, and the difference in the frequencies of occurrences forms the measure of similarity between the images. As illustrated in the Applicant's FIG. 4, block 434, and discussed in the specification at page 9, line 30 through page 10, line 3, in the example embodiment, the SumP and DiffP terms are specifically a difference between the frequency of occurrences, or proportion, of colors in each partition.

The Applicant respectfully maintains that ***comparing frequencies*** of occurrences of colors in each region, as specifically claimed in the Applicant's claims 6-10 and 16-20, is not taught by Sato. When Sato compares images, the comparison uses the index table, which, although it was created using the frequencies of occurrences of each color, does ***not*** contain frequencies of occurrences, and thus Sato's comparison cannot be said to be a comparison of frequencies of occurrences.

Further, in the Examiner's Answer, the Examiner asserts that Sato teaches a comparison of the frequencies of occurrences of colors at column 24, lines 4-26. The Applicant respectfully notes that at column 24, lines 4-26, Sato teaches comparing the ***similarity*** of colors, and not the ***frequency*** of colors. Throughout these cited lines, Sato specifically refers to the calculation of ***color distances***; nowhere in these cited lines does Sato refer to the proportions of colors or their frequencies of occurrences.

In claims 1-5 and 11-15, the Applicant specifically claims a characterization of the image that includes "a plurality of measures that are ***proportional*** to the frequency of occurrence of a plurality of colors". The Applicant respectfully notes that although Sato's histogram of FIG. 43 provides a plurality of measures that are proportional to the frequency of occurrence of a plurality of colors, this histogram is ***not*** included in the characterization of the image. Sato's characterization of the image is the index table of FIG. 45, and not the histogram of FIG. 43. Although Sato's entries in the index table are based on the histogram of FIG. 43, they are not ***proportional*** to the frequency of occurrence of a plurality of colors, as specifically claimed by the Applicant, as the term proportional is generally used in the art, consistent with the use of the term in the Applicant's specification.

The Applicant respectfully maintains that Sato uses the index table to characterize an image, and respectfully maintains that Sato's index table does not contain frequency of occurrences of colors. Because Sato specifically teaches the determination of frequencies of occurrences of colors, and then creates a characterization based on the frequencies of occurrences but ***not*** containing the frequencies of occurrences, or any measures that are proportional to the frequencies of occurrences, the Applicant

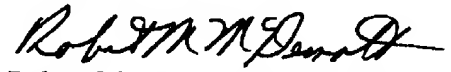
respectfully maintains that Sato does not teach a characterization that includes measures proportional to frequencies of occurrences, as specifically claimed in claims 1-5 and 11-15, and that Sato does not teach a comparison of images based on a comparison of frequencies of occurrences, as specifically claimed in claims 6-10 and 16-20.

CONCLUSIONS

Because Sato stores only an identifier of each region that contains a threshold amount of each color in the index table that characterizes the image, and does not store a measure proportionate to the frequency of occurrences of each color in each region in this index table, the Applicant respectfully requests that the Examiner's rejection of claims 1-5 and 11-15 under 35 U.S.C. 102(e) be reversed by the Board, and the claims be allowed to pass to issue.

Because Sato stores only an identifier of each region that contains a threshold amount of each color in the index table, and does not store the frequency of occurrence of each color in each region for subsequent comparisons using the index table, the Applicant respectfully requests that the Examiner's rejection of claims 6-10 and 16-20 under 35 U.S.C. 102(e) be reversed by the Board, and the claims be allowed to pass to issue.

Respectfully submitted,



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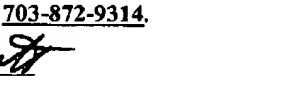
On 8 June 2003 By 

APPENDIX

CLAIMS ON APPEAL

1. A method for characterizing an image comprising:

partitioning the image into a plurality of partitions, each partition including a plurality of pixels, each pixel having a color,

determining a frequency of occurrence of each color of the plurality of pixels within each partition, and

creating a characterization that includes a plurality of measures that are proportional to the frequency of occurrence of a plurality of colors.

2. The method of claim 1, further including

quantizing an encoded color of each pixel to provide the color of each pixel.

3. The method of claim 2, further including

identifying a plurality of populous colors, based on the frequency of occurrence of each color, and

the plurality of measures includes proportions of each of the plurality of populous colors in each partition.

4. The method of claim 2, wherein

quantizing the encoded color includes

identifying a set of color centers, and

determining the color of each pixel based upon a color distance between the encoded color of each pixel and each of the set of color centers.

5. The method of claim 1, further including

identifying a plurality of populous colors, based on the frequency of occurrence of each color, and

the plurality of measures includes proportions of each of the plurality of populous colors in each partition.

6. A method of comparing a first image to a second image, comprising

partitioning the first image into a plurality of first partitions, each first partition including a plurality of first pixels, each first pixel having a color,

determining a frequency of occurrence of each color of the plurality of first pixels within each first partition,

partitioning the second image into a plurality of second partitions, each second partition including a plurality of second pixels, each second pixel having a color,

determining a frequency of occurrence of each color of the plurality of second pixels within each second partition

comparing the frequency of occurrence of a select set of colors in each first partition with the frequency of occurrence of a corresponding select set of colors in each second partition.

7. The method of claim 6, further including

quantizing an encoded color of each pixel of the plurality of first pixels to provide the color of each pixel of the plurality of first pixels.

8. The method of claim 7, further including

identifying a plurality of first populous colors, based on the frequency of occurrence of each color of the plurality of first pixels, and

identifying a plurality of second populous colors, based on the frequency of occurrence of each color of the plurality of second pixels; and

wherein

the select set of colors in each first partition corresponds to the plurality of first populous colors, and

the corresponding set of colors in each second partition is based upon a color difference between each of the plurality of second populous colors and the plurality of first populous colors.

9. The method of claim 7, wherein

quantizing the encoded color includes

identifying a set of color centers, and

determining the color of each pixel based upon a color distance between the encoded color of each pixel and each of the set of color centers.

10. The method of claim 6, further including

identifying a plurality of first populous colors, based on the frequency of occurrence of each color of the plurality of first pixels, and

identifying a plurality of second populous colors, based on the frequency of occurrence of each color of the plurality of second pixels; and

wherein

the select set of colors in each first partition corresponds to the plurality of first populous colors, and

the corresponding set of colors in each second partition is based upon a color difference between each of the plurality of second populous colors and the plurality of first populous colors.

11. A system for characterizing an image comprising:

a partitioner that is configured to partition the image into a plurality of partitions, each partition including a plurality of pixels, each pixel having a color, and

an accumulator that is configured to determine a frequency of occurrence of each color of the plurality of pixels within each partition, and

wherein

the system is configured to create a characterization of the image that includes a plurality of measures that are proportional to the frequency of occurrences of a plurality of colors.

12. The system of claim 11, further including

a quantizer that is configured to quantize an encoded color of each pixel to provide the color of each pixel.

13. The system of claim 12, wherein

the plurality of measures are based on the frequency of occurrence of each of a plurality of populous colors in each partition.

14. The system of claim 12, wherein

the quantizer is configured to quantize the encoded color based upon a color distance between the encoded color of each pixel and each of a set of color centers.

15. The system of claim 11, wherein

the plurality of measures are based on the frequency of occurrence of each of a plurality of populous colors in each partition.

16. A system for comparing a first image to a second image, the system comprising:

a similar color determinator that is configured to determine

a mapping between a first set of colors of pixels of the first image and a second set of colors of pixels of the second image, based on a color distance between each of the first set of colors and each of the second set of colors,

the mapping thereby providing a corresponding color in the second set of colors for each color in the first set of colors, and

a similarity determinator that is configured to determine an image similarity measure based on a comparison of a frequency of occurrence of pixels of each of the first set of colors and a frequency of occurrence of pixels of each of the corresponding colors in the second set of colors.

17. The system of claim 16, wherein

the first image is partitioned into a plurality of first partitions,

the second image is partitioned into a plurality of second partitions,

the similar color determinator is configured to determine the mapping between the first and second sets of colors of pixels for each partition of the plurality of first and second partitions, and

the similarity determinator is configured to determine a plurality of similarity measures based on the comparison of the frequencies of occurrence of pixels of each of the first and second set of colors for each partition of the plurality of first and second partitions, and further includes

an accumulator that is configured to provide the image similarity measure based on a composite of the plurality of similarity measures corresponding to each partition of the first and second partitions.

18. The system of claim 17, wherein

the similarity determinator is further configured to determine the similarity measure based upon the color distances between each of the first set of colors and the corresponding color in the second set of colors.

19. The system of claim 16, wherein

the first set of colors of the pixels of the first image is based on a quantization of encoded colors of the pixels of the first image.

20. The system of claim 17, wherein

the quantization of encoded colors is based on a color distance between the encoded color of each pixel and each of a set of color centers.